

A FRESH LOOK AT COUPLED-OSCILLATOR SPATIAL POWER COMBINING

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Quasi-optical oscillators were proposed a little more than ten years ago as a means of developing the power levels needed for applications at millimeter frequencies using large numbers of individual semiconductor devices each of which produces only a modest amount of power [J.W. Mink, *IEEE Trans. MTT.*, vol. 34, p. 273, 1986]. An operating system was demonstrated soon after [Z.B. Popovic *et. al*, *Int. J. Infrared and Millimeter Waves*, v. 9, p. 647, 1988] in the form of a so-called grid oscillator. This device constituted a rectangular array of oscillating devices that are mutually coupled so that they oscillator coherently. The interconnecting lines in one direction serve as radiators so that the oscillators radiate directly, and the radiated fields add. Subsequently, coupled oscillators using resonant transmission line lengths was demonstrated by Mortazawi and Itoh [*IEEE Trans. MTT.*, vol. 38, p. 86, 1990].

In recent work, coupled-oscillator power combiners have received less attention, with amplifier/combiners receiving more attention. Specific weaknesses of spatial-combining oscillators have motivated this transition. Namely, the oscillators employ low-Q resonators (resulting in low signal quality) and no clear means of modulation has been identified until recently.

In this presentation, we review coupled-oscillator combiners in broad terms, indicating the features that make particular systems viable. We indicate how these features can be reconciled to functional requirements for system applications. Comparisons are drawn between two approaches to obtain mutual coupling: One employs low-Q oscillator circuits at each site, with concomitantly high propensity for the oscillators to couple. The other approach employs moderate-Q oscillators at each site with the concomitant requirement to tune the oscillators so that they share a range of frequencies over which they can couple and lock. In either case, precise frequency control and modulation can be achieved through locking to an external frequency source that ensures high quality signals.

A recent development in coupled-oscillator arrays provides a means for beam-steering the radiation field of coupled oscillators through de-tuning of the edge elements in the array. This detuning introduces a progressive phase shift across the oscillator array. This suggests architectures that can replace the functionality of a phased array without the cost incurred by phase shifters. A comprehensive theory of the phase interactions among devices in such arrays is under development [*e.g.*, Pogorzelski, York, and Maccarini, 1998 AP-S International Symposium, Atlanta, GA, June, 1998].